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PATENT AND TRADEMARK CAUSES

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SENT TO: Ms. Somaia Basheir  
571 - 273 - 0459

DATE SENT: 8 SEPT 2006

SUBJECT: APPLN NO: 10/541,751 - OUR REF: PATCHORNIK 5

No. of pages (including this cover sheet): 46

FROM: ERIN D. GERAGHTY, OFFICE MANAGER

Remarks:

As discussed attached please find everything  
as previously submitted, along with receipt postcards.

09/12/2006 SBASHEIR 00000003 024035 10541751

01 10:2453

756.00 DA

## CONFIDENTIALITY NOTE

This confidential facsimile message is intended only for the individual entity named above, and may contain information that is privileged and exempt from disclosure under applicable law. If you, the reader of this message, are not the intended recipient, or the employee or agent responsible for delivering this message to the intended recipient, you are hereby notified that you should not copy this facsimile or distribute it to anyone other than the intended recipient. In addition, if you have received this telecopy in error, please immediately notify us by telephone or telefax and return the original message to us at the address above via the United States Postal Service. Finally, if it would not inconvenience you, we would appreciate it if you would first re fax this message to the intended recipient. Thank you.

If this transmission is not well received, please advise us at our telecopier no. 202-737-3528 or by e-mail at mail@browdyneimark.com, or call our voice telephone no. 202-628-5197.

## IN THE UNITED STATES PATENT AND TRADEMARK OFFICE

In re Application of:	)	Art Unit:
PATCHORNIK et al.	)	
IA No.: PCT/IL2003/000606	)	
IA Filed: 24 July 2003	)	Washington, D.C.
U.S. App. No.:	)	Con. No. 3902
23/541,751	)	
National Filing Date:	)	March 29, 2006
(Not Yet Received)	)	
For: ENERGY SAVING STARTUP ...	)	Docket No.: PATCHORNIK5

**PETITION TO VACATE HOLDING OF ABANDONMENT**

U.S. Patent and Trademark Office  
Customer Service Window  
Randolph Building, Mail Stop PCT  
401 Dulany Street  
Alexandria, VA 22314

Sir:

Applicant is in receipt of the Notice of Abandonment, mailed February 24, 2006, which states that the application is abandoned because of applicant's failure to provide the full U.S. Basic National Fee by 30 months (37 CFR 1.495).

It is respectfully requested that such Notice of Abandonment be vacated as being erroneous and that the present application be reinstated.

THE FACTS

In re Petition to Vacate Holding of Abandonment (PATCHORNIK5)

On July 8, 2005, the undersigned filed a Transmittal Letter to the United States Designated/Elected Office (DO/EO/US) Concerning a Filing Under 35 U.S.C. 371, along with a Petition to Revive Under 37 CFR 1.137(b). At the time these documents were filed, the basic, search and examination fees of \$500.00 were paid, along with the \$750.00 petition fee. The Petition was necessary as the 30 month deadline for national stage entry had expired on June 24, 2005. Said petition properly stated that the entire delay in filing the request for entry into the U.S. National Stage was unintentional.

As evidence that said documents were timely filed, attached please find a xerographic copy of the return postcard date-stamped by the PTO Mail Room as having been timely received by the PTO on July 8, 2005. Said postcard indicates that said transmittal was timely filed. While the postcard omits reference to the Petition to Revive filed with the transmittal, it does indicate that a fee of \$1250.00 was paid. Review of the second page of the transmittal indicates that the \$1,250.00 in fees being paid were the basic, search, examination fees, as well as a petition fee.

As it appears that the Petition to Revive Under 37 CFR 1.137(b) filed on July 8, 2005, has been lost by and in

In re Petition to Vacate Holding of Abandonment (PATCHORNIK5)

the PTO, attached hereto is a duplicate copy of the Petition dated July 8, 2005, and related papers.

REMARKS

In view of the above evidence, it is clear that the fees required by 37 CFR 1.495 were timely and properly filed and that the Notice of Abandonment has been issued in error. Indeed, the postcard by itself which indicates that the transmittal was filed along with a total fee of \$1,250.00, which transmittal letter in turn indicates that the fee included a petition fee, should be sufficient, as MPEP Section 503 states:

A postcard receipt which itemizes and properly identifies the papers which are being filed serves as *prima facie* evidence of receipt of the PTO of all items listed there on the date stamped thereon by the PTO.

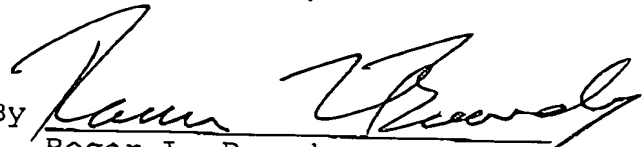
In the event that it is decided that insufficient proof has been filed that the Petition to Revive was filed on July 8, 2005, it is respectfully requested that the duplicate copy of the Petition attached hereto be considered a new petition to revive and the above-identified application be considered to have entered the U.S. National stage in a timely manner.

If a fee must be charged, please charge same to Deposit Account No. 02-4035, and then refund said fee as the

- 5 - In re Petition to Vacate Holding of Abandonment (PATCHORNIK5)

holding of abandonment is erroneous and is entirely the fault  
of the PTO.

BROWDY AND NEIMARK, P.L.L.C.  
Attorneys for Applicant

By   
Roger L. Browdy  
Registration No. 25,618

RLB:edg

Telephone No.: (202) 628-5197

Facsimile No.: (202) 737-3528

G:\BN\C\cohn\patchornik5\patent erroneous abandonment.doc

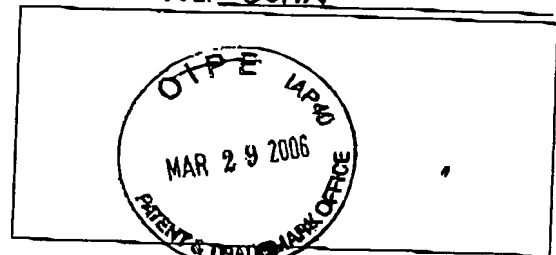
APPLICATION/PATENT NO: 10/541,751  
 DOCKET NO: PATCHORNIK

CONF. NO.: 3902  
 CLIENT CODE: COHN

THE PATENT AND TRADEMARK OFFICE STAMP  
 HEREON ACKNOWLEDGES RECEIPT OF THE  
 FOLLOWING PAPERS:

- ☐ FEES \$ \_\_\_\_\_ PTO FORM 2038  
☐ EXTENSION OF TIME (\_\_\_\_ MONTHS)  
☐ TRANSMITTAL LETTER  
☐ MISSING PARTS RESPONSE WITH DECL  
☐ AMENDMENT/RESPONSE (circle one)  
☐ PRELIMINARY ☐ SUPPLEMENTAL  
☒ APPLICATION DATA SHEET  
☐ RESTRICTION/ELECTION REPLY  
☐ SEQUENCE LISTING ☐ WITH DISK  
☐ RCE TRANSMITTAL  
☐ REQUEST FOR STATUS  
☐ NOTICE OF APPEAL  
☐ APPEAL BRIEF/REPLY BRIEF (TRIPPLICATE)  
☐ REQUEST & CERTIFICATE OF CORRECTION

☒ OTHER Rejection to Vacate. Holding of Abandonment including copies of Rejection to Vacate  
Under 37 CFR 1.137(b), Transmittal Letter to the United States Department of State  
Office Concerning a Filing Under 35 U.S.C. 371 (AOS, 1st pg of Pub, ISR, DEC, Pct. And,  
Courtesy copy of Pat Appln. : postcard



- ☐ ASSIGNMENT  
☐ INFORMATION DISCLOSURE STATEMENT  
☐ FORM SB08A & \_\_\_\_\_ PATENTS/PUBS  
☐ PRIORITY DOCUMENT(S) NO. \_\_\_\_\_  
☐ DECLARATION UNDER § \_\_\_\_\_  
☐ \_\_\_\_\_ SHEETS OF FORMAL DRAWINGS  
☐ ISSUE FEE TRANSMITTAL FORM  
☐ PUBLICATION FEE  
☐ MAINTENANCE FEE LETTER

B&N-1

IN THE UNITED STATES PATENT AND TRADEMARK OFFICE  
PCT UNITED STATES ELECTED OFFICE

In re Application of:	)	Art Unit:
PATCHORNIK et al.	)	
IA No.: PCT/IL2003/000606	)	
IA Filed: 24 July 2003	)	Washington, D.C.
U.S. App. No.:	)	
(Not Yet Assigned)	)	
National Filing Date:	)	July 8, 2005
(Not Yet Received)	)	
For: ENERGY SAVING STARTUP ...	)	Docket No.:
		PATCHORNIK5

**PETITION TO REVIVE UNDER 37 CFR 1.137(b)**

U.S. Patent and Trademark Office  
Customer Service Window  
Randolph Building, Mail Stop PCT  
401 Dulany Street  
Alexandria, VA 22314

Sir:

Applicants, through their undersigned attorney, hereby petition for the revival of this application for entry of this application into the U.S. National Phase under 35 USC 371. This application became abandoned for failure to enter the U.S. national phase of PCT/IL2003/000606 by filing appropriate papers with the U.S. Designated Office within 30 months of the priority date.

Under 37 CFR \$1.137(b), a petition to revive an unintentionally abandoned application must be accompanied by (1) a statement that the delay in filing was unintentional, (2) a proposed response unless it has been previously filed, and (3) a fee in the amount of \$750.00 for a small entity.

(1) Applicant, through undersigned counsel, hereby

In re Appln. No. PCT/IL03/00606

states that the entire delay in filing the papers necessary to perfect the completion of entry into the U.S. national phase of this case from the due date for entry into the U.S. national phase (June 24, 2005) until the filing of this grantable petition, was unintentional.

(2) Papers required for entering the U.S. national phase of this application are attached hereto.

(3) A petition fee in the amount of \$750.00 as required by 37 C.F.R. §1.17(m) is included in credit card authorization form PTO-2038 attached hereto.

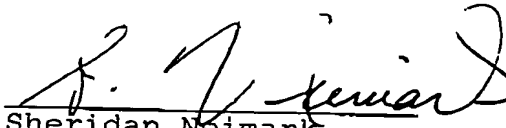
It is believed that the granting of this petition and the revival of this application (for entry into the U.S. national phase) are in order. Such is respectfully requested.

Please charge any additional fees which may be necessary with respect to the revival of this application, or credit any overpayment, to deposit account no. 02-4035 of the undersigned.

Respectfully submitted,

BROWDY AND NEIMARK, P.L.L.C.  
Attorneys for Applicant(s)

By:

  
Sheridan Neimark

Registration No. 20,520

SN:edg

Telephone No.: (202) 628-5197

Facsimile No.: (202) 737-3528

G:\BN\C\cohn\patchornik5\petition to revive.doc



U.S. DEPARTMENT OF COMMERCE PATENT AND TRADEMARK OFFICE		ATTORNEY'S DOCKET NUMBER <b>PATCHORNIK5</b>
<b>TRANSMITTAL LETTER TO THE UNITED STATES DESIGNATED/ELECTED OFFICE (DO/EO/US) CONCERNING A FILING UNDER 35 U.S.C. 371</b>		U.S. APPLICATION NO. (If known, see 37 CFR 1.5)
INTERNATIONAL APPLICATION NO. <b>PCT/IL2003/000606</b>	INTERNATIONAL FILING DATE <b>24 July 2003</b>	PRIORITY CLAIMED <b>24 December 2002</b>
TITLE OF INVENTION <b>ENERGY SAVING STARTUP CIRCUIT FOR POWER SUPPLY</b>		
APPLICANT(S) FOR DO/EO/US <b>Joshua PATCHORNIK</b>		
<p>Applicant herewith submits to the United States Designated/Elected Office (DO/EO/US) the following items and other information:</p> <ol style="list-style-type: none"> <li><input checked="" type="checkbox"/> This is a <b>FIRST</b> submission of items concerning a filing under 35 U.S.C. 371.</li> <li><input type="checkbox"/> This is a <b>SECOND</b> or <b>SUBSEQUENT</b> submission of items concerning a filing under 35 U.S.C. 371.</li> <li><input checked="" type="checkbox"/> This is an express request to begin national examination procedures (35 U.S.C. 371(f)) as soon as the application is in order for such purpose and the applicable requirements of 35 U.S.C. 371(c) have been complied with.</li> <li><input checked="" type="checkbox"/> The US has been elected (Art 31).</li> <li><input checked="" type="checkbox"/> A copy of the International Application as filed (35 U.S.C. 371(c)(2))             <ol style="list-style-type: none"> <li><input type="checkbox"/> is attached hereto (required only if not transmitted by the International Bureau).</li> <li><input checked="" type="checkbox"/> has been communicated by the International Bureau.</li> <li><input type="checkbox"/> is not required, as the application was filed in the United States Receiving Office (RO/US).</li> </ol> </li> <li><input type="checkbox"/> An English language translation of the International Application as filed (35 U.S.C. 371(c)(2)).             <ol style="list-style-type: none"> <li><input type="checkbox"/> is attached hereto.</li> <li><input type="checkbox"/> has been previously submitted under 35 U.S.C. 154(d)(4).</li> </ol> </li> <li><input checked="" type="checkbox"/> Amendments to the claims of the International Application under PCT Article 19 (35 U.S.C. 371(c)(3))             <ol style="list-style-type: none"> <li><input type="checkbox"/> are transmitted herewith (required only if not transmitted by the International Bureau).</li> <li><input type="checkbox"/> have been communicated by the International Bureau.</li> <li><input type="checkbox"/> have not been made; however, the time limit for making such amendments has NOT expired.</li> <li><input checked="" type="checkbox"/> have not been made and will not be made.</li> </ol> </li> <li><input type="checkbox"/> An English language translation of the amendments to the claims under PCT Article 19 (35 U.S.C. 371(c)(3)).</li> <li><input checked="" type="checkbox"/> An oath or declaration of the inventor(s) (35 U.S.C. 371(c)(4)).</li> <li><input type="checkbox"/> An English language translation of the annexes to the International Preliminary Examination Report under PCT Article 36 (35 U.S.C. 371(c)(5)).</li> </ol> <p>Items 11. to 16. below concern document(s) or information included:</p> <ol style="list-style-type: none"> <li><input type="checkbox"/> An Information Disclosure Statement under 37 CFR 1.97 and 1.98.</li> <li><input type="checkbox"/> An Assignment document for recording. A separate cover sheet in compliance with 37 CFR 3.28 and 3.31 is included.</li> <li><input type="checkbox"/> A FIRST preliminary amendment.</li> <li><input checked="" type="checkbox"/> An Application Data Sheet under 37 CFR 1.76.</li> <li><input type="checkbox"/> A substitute specification.</li> <li><input type="checkbox"/> A change of power of attorney and/or address letter.</li> <li><input type="checkbox"/> A computer-readable sequence form of the sequence listing in accordance with PCT Rule 13ter.2 and 37 CFR 1.821-1.825.</li> <li><input type="checkbox"/> A second copy of the published International Application under 35 U.S.C. 154(d)(4).</li> <li><input type="checkbox"/> A second copy of the English language translation of the international application under 35 U.S.C. 154(d)(4)</li> <li><input checked="" type="checkbox"/> Other items or information:             <ul style="list-style-type: none"> <li><input checked="" type="checkbox"/> Courtesy copy of the International Application as filed.</li> <li><input checked="" type="checkbox"/> Courtesy copy of the first page of the International Publication (WO 2004/059824).</li> <li><input checked="" type="checkbox"/> Courtesy copy of the search report.</li> <li><input checked="" type="checkbox"/> Formal drawings, <u>4</u> sheets, Figures <u>1-4</u>.</li> <li><input checked="" type="checkbox"/> The application is (or will be) assigned to: <b>LIGHTTECH ELECTRONIC INDUSTRIES LTD.</b>, whose address is <b>9 Hamelacha Street, Northern Industrial Zone, 71520 Lod, Israel</b></li> </ul> </li> </ol>		

U.S. APPLICATION NO. (If known, see 37 CFR 1.5)		International Application No. <b>PCT/IL2003/000606</b>		Attorney's Docket No. <b>PATCHORNIK5</b>	
21. The following fees are submitted:  <input checked="" type="checkbox"/> a) BASIC FILING FEE.....\$300.00 <input checked="" type="checkbox"/> b) EXAMINATION FEE.....\$200.00 <input checked="" type="checkbox"/> c) SEARCH FEE.....\$500.00  <div style="text-align: right;">TOTAL OF ABOVE CALCULATIONS :</div>				<b>CALCULATIONS PTO USE ONLY</b>	
Surcharge of \$130.00 for furnishing the oath or declaration later than [ ] 20 [ ] 30 months from the earliest claimed priority date (37 CFR 1.492(c)).				\$ 1,000.00	
TOTAL SHEETS	EXTRA SHEETS	Number of each additional 50 or fraction thereof (round up to a whole number)	RATE		
17 - 100	/50		X \$250.00		
CLAIMS		Number Filed	Number Extra	Rate	
Total Claims		18 - 20 =		X \$ 50.00	\$
Independent Claims		3 - 3 =		X \$200.00	\$
Multiple Dependent Claims (if applicable)			+ \$360.00		\$
TOTAL OF ABOVE CALCULATIONS =				\$	
Reduction of 1/2 for filing by small entity, if applicable. Applicant claims small entity status. See 37 CFR 1.27.				\$ 500.00	
SUBTOTAL =				\$ 500.00	
Processing Fee of \$130.00 for furnishing the English translation later than [ ] 20 [ ] 30 months from the earliest claimed priority date (37 CFR 1.492(f)).				\$	
TOTAL NATIONAL FEE =				\$ 500.00	
Fee for recording the enclosed assignment (37 CFR 1.21(h)). The assignment must be accompanied by an appropriate cover sheet (37 CFR 3.28, 3.31). \$40.00 per property +				\$	
TOTAL FEES ENCLOSED =				\$ 500.00	
				Amount to be:	\$
				refunded	
				charged	\$
<p>a. [ ] A check in the amount of \$ _____ to cover the above fees is enclosed.</p> <p>b. <input checked="" type="checkbox"/> Credit Card Payment Form (PTO-2038), authorizing payment in the amount of \$1,250.00, is attached, which is to cover the basic, search and examination fees along with the petition fee.</p> <p>c. [ ] Please charge my Deposit Account No. 02-4035 in the amount of \$ _____ to cover the above fees. A duplicate copy of this sheet is enclosed.</p> <p>d. <input checked="" type="checkbox"/> The Commissioner is hereby authorized to charge any additional fees which may be required, or credit any overpayment to Deposit Account No. 02-4035. A duplicate copy of this sheet is enclosed.</p> <p><b>NOTE:</b> Where an appropriate time limit under 37 CFR 1.494 or 1.495 has not been met, a petition to revive (37 CFR 1.137(a) or (b)) must be filed and granted to restore the application to pending status.</p> <p>Direct all correspondence to the address associated with CUSTOMER NUMBER 001444, which is currently:</p> <p><b>BROWDY AND NEIMARK, P.L.L.C.</b>  <b>624 NINTH STREET, N.W., SUITE 300</b>  <b>WASHINGTON, D.C. 20001</b>  <b>TEL: (202) 628-5197</b>  <b>FAX: (202) 737-3528</b>  <b>Date of this submission: July 8, 2005</b></p>					
				SIGNATURE	
				Sheridan Neimark	
				NAME	
				20,520	
				REGISTRATION NUMBER	
				SN:edg	

**Application Data Sheet****Application Information**

Application Type::	Regular
Subject Matter::	Utility
Suggested Classification::	
Suggested Group Art Unit::	
CD-ROM or CD-R?::	None
Number of CD Disks::	
Number of Copies of CDs::	
Sequence Submission?::	
Computer Readable Form (CRF)?::	
Number of copies of CRF::	
Title::	ENERGY SAVING STARTUP CIRCUIT FOR POWER SUPPLY
Attorney Docket Number::	PATCHORNIK5
Request for Early Publication?::	No
Request for Non-Publication?::	No
Suggested Drawing Figure::	
Total Drawing Sheets::	4
Small Entity?::	Yes
Latin Name::	
Variety Denomination Name::	
Petition Included::	No
Petition Type::	
Licensed US Govt. Agency::	
Contract or Grant Numbers::	
Secrecy Order in Parent Appl.?::	No
<b>Applicant Information</b>	
Applicant Authority Type::	Inventor
Primary Citizenship Country::	Israel
Status::	Full Capacity
Given Name::	Joshua

Middle Name::

Family Name::

PATCHORNIK

Name Suffix::

City of Residence::

Ramat Gan

State or Province of Residence::

Country of Residence::

Israel

Street of Mailing Address::

9 Etzion Street

City of Mailing Address::

Ramat Gan

State or Province of Mailing Address::

Country of Mailing Address::

Israel

Postal or Zip Code of Mailing Address::

52383

**Correspondence Information**

Correspondence Customer Number::

001444

**Representative Information**

Representative Customer Number::

001444

**Domestic Priority Information**

Application::

Continuity Type::

Parent

Parent Filing

Application::

Date::

This Application

National Stage of

PCT/IL2003/00060

07/24/03

6

**Foreign Priority Information**

Country::

Application Number::

Filing Date::

Priority Claimed::

Israel

153606

12/24/20

Yes

**Assignment Information**

Assignee Name::

LIGHTECH ELECTRONIC INDUSTRIES  
LTD.

Street of Mailing Address::

9 Hamelacha Street, Northern Industrial  
Zone

City of Mailing Address::

Lod

**State or Province of Mailing Address::**

**Country of Mailing Address::**

**Israel**

**Postal or Zip Code of Mailing Address::**

**71520**

**Application Data Sheet****Application Information**

Application Type::	Regular
Subject Matter::	Utility
Suggested Classification::	
Suggested Group Art Unit::	
CD-ROM or CD-R?::	None
Number of CD Disks::	
Number of Copies of CDs::	
Sequence Submission?::	
Computer Readable Form (CRF)?::	
Number of copies of CRF::	
Title::	ENERGY SAVING STARTUP CIRCUIT FOR POWER SUPPLY
Attorney Docket Number::	PATCHORNIK5
Request for Early Publication?::	No
Request for Non-Publication?::	No
Suggested Drawing Figure::	
Total Drawing Sheets::	4
Small Entity?::	Yes
Latin Name::	
Variety Denomination Name::	
Petition Included::	No
Petition Type::	
Licensed US Govt. Agency::	
Contract or Grant Numbers::	
Secrecy Order in Parent Appl.?::	No
<b>Applicant Information</b>	
Applicant Authority Type::	Inventor
Primary Citizenship Country::	Israel
Status::	Full Capacity
Given Name::	Joshua

Middle Name::

Family Name::

PATCHORNIK

Name Suffix::

City of Residence::

Ramat Gan

State or Province of Residence::

Country of Residence::

Israel

Street of Mailing Address::

9 Etzion Street

City of Mailing Address::

Ramat Gan

State or Province of Mailing Address::

Country of Mailing Address::

Israel

Postal or Zip Code of Mailing Address::

52383

**Correspondence Information**

Correspondence Customer Number::

001444

**Representative Information**

Representative Customer Number::

001444

**Domestic Priority Information**

Application:: Continuity Type::

Parent

Parent Filing

Application::

Date::

This Application National Stage of

PCT/IL2003/00060

07/24/03

6

**Foreign Priority Information**

Country::

Application Number::

Filing Date::

Priority Claimed::

Israel

153606

12/24/20

Yes

**Assignment Information**

Assignee Name::

LIGHTTECH ELECTRONIC INDUSTRIES  
LTD.

Street of Mailing Address::

9 Hamelacha Street, Northern Industrial  
Zone

City of Mailing Address::

Lod

State or Province of Mailing Address::

Country of Mailing Address::

Israel

Postal or Zip Code of Mailing Address::

71520



## (12) INTERNATIONAL APPLICATION PUBLISHED UNDER THE PATENT COOPERATION TREATY (PCT)

(19) World Intellectual Property  
Organization  
International Bureau



INTERNATIONAL BUREAU OF PATENT COOPERATION  
3, rue de la Harpe, CH-1015, Yvertois, Suisse  
P.O. Box 68, CH-1015, Yvertois, Suisse  
Tél. (021) 261 81 11, Fax (021) 261 81 12  
E-mail: wipo@wipo.int

(43) International Publication Date  
15 July 2004 (15.07.2004)

PCT

(10) International Publication Number  
**WO 2004/059824 A1**

(51) International Patent Classification<sup>7</sup>: H02M 3/335, 1/12

(74) Agent: REINHOLD COHN AND PARTNERS; P.O.Box 4060, 61040 Tel-Aviv (IL).

(21) International Application Number:  
PCT/IL2003/000606

(81) Designated States (*national*): AE, AG, AL, AM, AT, AU, AZ, BA, BB, BG, BR, BY, BZ, CA, CH, CN, CO, CR, CU, CZ, DE, DK, DM, DZ, EC, EE, ES, FI, GB, GD, GE, GH, GM, HR, HU, ID, IL, IN, IS, JP, KE, KG, KP, KR, KZ, LC, LK, LR, LS, LT, LU, LV, MA, MD, MG, MK, MN, MW, MX, MZ, NI, NO, NZ, OM, PG, PH, PL, PT, RO, RU, SC, SD, SE, SG, SK, SL, SY, TJ, TM, TN, TR, TT, TZ, UA, UG, US, UZ, VC, VN, YU, ZA, ZM, ZW.

(22) International Filing Date: 24 July 2003 (24.07.2003)

(25) Filing Language: English

(26) Publication Language: English

(30) Priority Data:  
153606 24 December 2002 (24.12.2002) IL

(84) Designated States (*regional*): ARIPO patent (GH, GM, KB, LS, MW, MZ, SD, SL, SZ, TZ, UG, ZM, ZW), Eurasian patent (AM, AZ, BY, KG, KZ, MD, RU, TJ, TM), European patent (AT, BE, BG, CH, CY, CZ, DE, DK, EE, ES, FI, FR, GB, GR, HU, IE, IT, LU, MC, NL, PT, RO, SE, SI, SK, TR), OAPI patent (BF, BJ, CF, CG, CI, CM, GA, GN, GQ, GW, ML, MR, NE, SN, TD, TG).

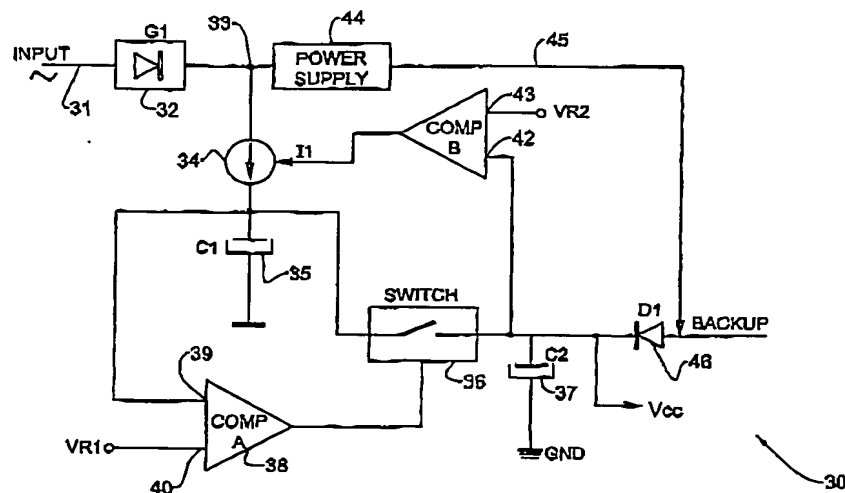
(71) Applicant (*for all designated States except US*):  
LIGHTTECH ELECTRONIC INDUSTRIES LTD.  
[IL/IL]; 9 Hamelscha Street, Northern Industrial Zone,  
71520 Lod (IL).

Published:  
— with international search report

(72) Inventor; and  
(75) Inventor/Applicant (*for US only*): PATCHORNIK,  
Joshua [IL/IL]; 9 Etzion Street, 52383 Ramat Gan (IL).

For two-letter codes and other abbreviations, refer to the "Guidance Notes on Codes and Abbreviations" appearing at the beginning of each regular issue of the PCT Gazette.

(54) Title: ENERGY SAVING STARTUP CIRCUIT FOR POWER SUPPLY



(57) Abstract: A startup circuit (30) for a power supply (44), has an input (31) for connecting a source of high voltage thereto, and an output rail (33) for feeding rectified voltage to the power supply. A first energy storage device (35) is coupled to the output rail for storing energy when voltage is first applied to the input, and a second energy storage device (37) is coupled to an output of the power supply for storing energy when a voltage appearing at the output of the power supply reaches substantially steady state. A switching circuit (36, 38) is coupled to the first energy storage device and to the second energy storage device and is responsive to the first energy storage device having sufficient energy for transferring the energy to the second energy storage device and disconnecting the first energy storage device from the output rail.

WO 2004/059824 A1

## INTERNATIONAL SEARCH REPORT

International Application No.  
PCT/IL 03/00606

## A. CLASSIFICATION OF SUBJECT MATTER

IPC 7 H02M3/335 H02M1/12

According to International Patent Classification (IPC) or to both national classification and IPC

## B. FIELDS SEARCHED

Minimum documentation searched (classification system followed by classification symbols)

IPC 7 H02M

Documentation searched other than minimum documentation to the extent that such documents are included in the fields searched

Electronic data base consulted during the international search (name of data base and, where practical, search terms used)

EP0-Internal, WPI Data, PAJ

## C. DOCUMENTS CONSIDERED TO BE RELEVANT

Category *	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
Y	DE 42 27 183 A (GOSSEN GMBH) 24 February 1994 (1994-02-24) column 2, line 14 - line 40; figure	1-16
Y	US 6 246 596 B1 (YAMAZAKI HIROSHI) 12 June 2001 (2001-06-12) column 7, line 67 - column 8, line 10; figure 1	1-16
A	US 5 880 942 A (LEU FANG-JYE) 9 March 1999 (1999-03-09) the whole document	1-16

☐ Further documents are listed in the continuation of box C.

☒ Patent family members are listed in annex.

## \* Special categories of cited documents:

- "A" document defining the general state of the art which is not considered to be of particular relevance
- "E" earlier document but published on or after the international filing date
- "L" document which may throw doubts on priority claim(s) or which is cited to establish the publication date of another citation or other special reason (as specified)
- "O" document referring to an oral disclosure, use, exhibition or other means
- "P" document published prior to the international filing date but later than the priority date claimed

- "T" later document published after the international filing date or priority date and not in conflict with the application but cited to understand the principle or theory underlying the invention
- "X" document of particular relevance; the claimed invention cannot be considered novel or cannot be considered to involve an inventive step when the document is taken alone
- "Y" document of particular relevance; the claimed invention cannot be considered to involve an inventive step when the document is combined with one or more other such documents, such combination being obvious to a person skilled in the art
- "&" document member of the same patent family

Date of the actual completion of the international search

19 November 2003

Date of mailing of the international search report

10/12/2003

Name and mailing address of the ISA

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Gentili, L

## INTERNATIONAL SEARCH REPORT

Information on patent family members

International Application No  
PCT/IL 03/00606

Patent document cited in search report		Publication date	Patent family member(s)	Publication date
DE 4227183	A	24-02-1994	DE 4227183 A1	24-02-1994
US 6246596	B1	12-06-2001	JP 3236587 B2 JP 2001103743 A	10-12-2001 13-04-2001
US 5880942	A	09-03-1999	DE 19748465 A1	01-10-1998

Attorney's Docket No.

**COMBINED DECLARATION AND POWER OF ATTORNEY**

As a below named inventor, I hereby declare that:

My residence, post office address and citizenship are as stated below next to my name.

I believe I am the original, first and sole inventor (if only one name is listed below) or an original, first and joint inventor (if plural names are listed below) of the subject matter which is claimed and for which a patent is sought on the invention entitled ENERGY SAVING STARTUP CIRCUIT FOR POWER SUPPLY, the specification of which:

- ☐ is attached hereto,  
☐ was filed on \_\_\_\_\_ as Application Serial No. \_\_\_\_\_ and was amended on \_\_\_\_\_.  
☒ was described and claimed in PCT International Application No. PCT/IL03/00606 filed on July 24, 2003 and as amended under PCT Article 34 on July 21, 2004.

I hereby state that I have reviewed and understand the contents of the above-identified specification, including the claims, as amended by any amendment referred to above.

I acknowledge the duty to disclose information which is material to patentability as defined in 37 CFR 1.56, including for continuation-in-part applications, material information which became available between the filing date of the prior application and the national or PCT international filing date of the continuation-in-part application.

I hereby claim the benefit under Title 35, United States Code, §119(e)(1) of any United States provisional application(s) listed below:

U.S. Serial No.	Filing Date	Status
-----------------	-------------	--------

I hereby claim the benefit under 35 U.S.C. §120 of any prior U.S. non-provisional application(s) or under §365(c) of any prior PCT international application(s) designating the U.S., listed below and, insofar as the subject matter of each of the claims of this application is not disclosed in such U.S. or PCT international application in the manner provided by the first paragraph of 35 U.S.C. §112, I acknowledge the duty to disclose to the PTO all information which is material to patentability as defined in 37 C.F.R. §1.56 which became available between the filing date of the prior application and the national or PCT international filing date of this application:

Application Serial No.	Filing Date	Status
------------------------	-------------	--------

I hereby claim foreign priority benefits under 35 U.S.C. §§ 119 (a)-(d) and 365 (b) of any prior foreign application(s) for patent, inventor's or plant breeder's rights certificate(s), or under §365(a) of any PCT international application(s) designating at least one country other than the United States of America listed below and have also identified below any foreign application for patent or inventor's certificate or any PCT international application(s) designating at least one country other than the United States of America filed by me on the same subject matter having a filing date before that of the application(s) of which priority is claimed:

Country	Application No.	Filing Date	Priority Claimed
Israel (IL)	153606	December 24, 2002	<input checked="" type="checkbox"/>

Attorney's Docket No.

**Combined Declaration and Power of Attorney**  
Page 2 of 2 Pages.

As a named inventor, I hereby appoint the following registered practitioners to prosecute this application and to transact all business in the Patent and Trademark Office connected therewith:

All of the practitioners associated with Customer Number 001444

Direct all correspondence to the address associated with Customer Number 001444, which is presently:

BROWDY AND NEIMARK, P.L.L.C.  
624 Ninth Street, N.W.  
Washington, D.C. 20001-5303  
(202) 628-5197

The undersigned hereby authorizes the U.S. Attorneys or Agents appointed herein to accept and follow instructions from Reinhold Cohn and Partners as to any action to be taken in the U.S. Patent and Trademark Office regarding this application without direct communication between the U.S. Attorneys or Agents and the undersigned. In the event of a change of the persons from whom instructions may be taken, the U.S. Attorneys or Agents appointed herein will be so notified by the undersigned.

I hereby further declare that all statements made herein of my own knowledge are true and that all statements made on information and belief are believed to be true; and that these statements were made with the knowledge that willful false statements and the like so made are punishable by fine or imprisonment, or both, under 18 U.S.C. §1001 and that such willful false statements may jeopardize the validity of the application or any patent issued thereon.

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Ramat Gan 52383  
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Date: 2.9.5.05

## IN THE UNITED STATES PATENT AND TRADEMARK OFFICE

In re Application of:	)	Art Unit:
PATCHORNIK et al.	)	
	)	
IA No.: PCT/IL2003/000606	)	
	)	Washington, D.C.
IA Filed: 24 July 2003	)	
	)	
U.S. App. No.:	)	
(Not Yet Assigned)	)	
	)	July 8, 2005
National Filing Date:	)	
(Not Yet Received)	)	
	)	
For: ENERGY SAVING STARTUP ...	)	Docket No.:
		PATCHORNIK5

## PRELIMINARY AMENDMENT

U.S. Patent and Trademark Office  
Customer Service Window  
Randolph Building, Mail Stop Amendment  
401 Dulany Street  
Alexandria, VA 22314

Sir:

Prior to examination on the merits, and prior to calculation of the filing fee, kindly amend as follows:

Amendments to the Claims are reflected in the listing of claims which begins on page 2 of this paper.

Remarks begin on page 8.

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Amendments to the Claims:

This listing of claims will replace all prior versions, and listings, of claims in the application:

Listing of Claims:

Claims 1-16 (cancelled).

17 (New). Startup circuit for a power supply, said startup circuit comprising:

an input for connecting a source of high voltage thereto,

an output rail for feeding rectified voltage to the power supply,

a first energy storage device coupled to the output rail for storing energy when voltage is first applied to the input,

a second energy storage device coupled to an output of the power supply for storing energy when a voltage appearing at the output of the power supply reaches substantially steady state, and

a switching circuit coupled to the first energy storage device and to the second energy storage device and being responsive to the first energy storage device having

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sufficient energy for transferring said energy to the second energy storage device and disconnecting the first energy storage device from the output rail;

**characterized in that:**

the power supply is a universal or variable power supply that is adapted to operate over a range of power supply voltages fed to said input,

a starting resistor is coupled between the output rail and the first energy storage device for sourcing current to the first energy storage device, and

the switching circuit is responsive to the first energy storage device having sufficient energy for disconnecting the starting resistor from the output rail.

18 (New). The startup circuit according to claim 17, being part of a power supply for an LED lighting system.

19 (New). The startup circuit according to claim 17, wherein the first energy storage device is a first capacitor.

20 (New). The startup circuit according to claim 17, wherein the second energy storage device is a second capacitor.

21 (New). The startup circuit according to claim 19, including:



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a current source connected to the input for charging the first capacitor, and

a first comparator having a first input coupled to an output of the first capacitor and having a second input connected to a first reference voltage for generating a first switching signal when the output of the first capacitor exceeds the first reference voltage;

a second comparator having a first input coupled to an output of the second capacitor and having a second input connected to a second reference voltage for generating a second switching signal when the output of the second capacitor exceeds the second reference voltage;

said switching circuit being responsive to the first switching signal for changing from an initially open circuit wherein the first capacitor is isolated from the second capacitor to a closed circuit whereby the first capacitor is connected in parallel with the second capacitor; and being responsive to the second switching signal for disabling charge flow to the first capacitor.

22 (New). The startup circuit according to claim 21, wherein the switching circuit includes:

a first switch coupled to the current source and having an initial state wherein the current source is coupled

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to the first capacitor and having a second state wherein the current source is decoupled from the first capacitor, and

a second normally open switch coupled between respective outputs of the first and second capacitors.

23 (New). The startup circuit according to claim 22, wherein the first and second switches include semiconductor devices.

24 (New). The startup circuit according to claim 23, wherein the first and second switches are bipolar junction transistors.

25 (New). The startup circuit according to claim 21, wherein the first comparator includes a zener diode.

26 (New). The startup circuit according to claim 21, wherein the second comparator includes a zener diode.

27 (New). The startup circuit according to claim 21, wherein the current source includes a transistor for feeding current through a resistor.

28 (New). The startup circuit according to claim 21, wherein the switching circuit includes a first switch comprising resistors in combination with a transistor for controlling the current source.

29 (New). The startup circuit according to claim 21, wherein the switching circuit includes a second switch comprising resistors in combination with a transistor.

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30 (New). A universal or variable power supply including a startup circuit, said startup circuit including:  
an input for connecting a source of high voltage thereto,

an output rail for feeding rectified voltage to the power supply,

a first energy storage device coupled to the output rail for storing energy when voltage is first applied to the input,

a second energy storage device coupled to an output of the power supply for storing energy when a voltage appearing at the output of the power supply reaches substantially steady state, and

a switching circuit coupled to the first energy storage device and to the second energy storage device and being responsive to the first energy storage device having sufficient energy for transferring said energy to the second energy storage device and disconnecting the first energy storage device from the output rail;

**characterized in that**

the power supply is a universal or variable power supply that is adapted to operate over a range of power supply voltages fed to said input,

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a starting resistor is coupled between the output rail and the first energy storage device for sourcing current to the first energy storage device, and

the switching circuit is responsive to the first energy storage device having sufficient energy for disconnecting the starting resistor from the output rail.

31 (New). The universal or variable power supply according to claim 30, being an integral unit.

32 (New). The universal or variable power supply according to claim 30, being part of an LED lighting system.

33 (New). The universal or variable power supply according to claim 30, including a power factor correction circuit.

34 (New). A method for achieving substantially constant losses in a universal or variable power supply having an output rail that feeds current to a capacitor via a resistor and is coupled to a lamp control circuit that is fed by a backup power supply in steady state, the method comprising:

decoupling the resistor from the output rail when steady state is achieved so as to eliminate losses through the resistor.

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REMARKS

Claims 17 - 34 presently appear in this case. The amendments to the claims are being made to eliminate all multiple dependencies, so as to reduce the filing fee, and to place the case in better condition for examination. Please enter this amendment prior to calculation of the filing fee.

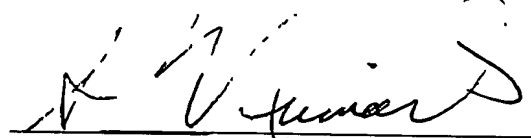
The amendments made above are not "narrowing" amendments. The scope of the claims has not been reduced; no limitations have been added and none are intended.

Prompt consideration on the merits and allowance are earnestly solicited.

Respectfully submitted,

BROWDY AND NEIMARK, P.L.L.C.  
Attorneys for Applicant(s)

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PCT APPLICATION  
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PCT/IL2003/000606

## Energy saving startup circuit for power supply

### FIELD OF THE INVENTION

This invention relates to startup circuits for driving low voltage equipment such as light emitting diodes (LEDs).

### BACKGROUND OF THE INVENTION

5       Electrical equipment requiring low voltage DC are frequently energized by mains operated power supplies. Fig. 1 shows schematically a conventional startup circuit 1 in a typical low voltage power supply, wherein mains voltage 2 is rectified typically by a bridge rectifier 3 and then fed via a resistor 4 to a control circuit (not shown) in the power supply. The input voltage to the control circuit is maintained at  
10 a required level by a zener diode 5 connected in parallel with a capacitor 6.

During operation, the resistor 4, which will be referred throughout as a "starting resistor", feeds current to the capacitor 6 which therefore charges to a value determined by the zener diode 5, thus ensuring a constant voltage input to the control circuit. Typically, the mains voltage is 110 VAC in the USA or 220 VAC in  
15 Europe, while the equipment operates on a much lower voltage, such as 30 volts or even less. The startup circuit 1 serves to energize the power supply directly from the mains supply after it is first switched on in a controlled manner. However, once the power supply is operating and has reached a steady state voltage, there is no longer any need to supply energy to the starting circuit, which is now redundant.

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A drawback with the arrangement shown in Fig. 1 is that even under steady state conditions, when the starting circuit is no longer necessary, the constant flow of current through the starting resistor 4 manifests itself as a constant energy loss, thus reducing the overall efficiency of the power supply. The amount of power  
5 dissipated in the starting resistor 4 is a function of the difference between the input voltage and the output voltage, since the closer the output voltage is to the input voltage in the steady state, the less is the voltage dropped across the starting resistor and therefore the lower is the energy loss therethrough. In power supplies designed to operate from a single voltage power supply only, it is possible to optimize the  
10 circuit components so as to reduce the constant energy loss through the starting resistor. However, in so-called universal power supplies that are intended to operate over a range of power supply voltages, such as 85-277 VAC so as to be suitable for both the US and European markets, such optimization is difficult to achieve and it becomes impossible to minimize the energy loss through the starting resistor for all  
15 supply voltages.

It would therefore be desirable to dispense with the starting resistor once the power supply is operating normally and reaches steady state. The prior art has recognized this need although apparently not in a universal power supply. Thus, reference is made to Fig. 2 showing a prior art power supply 10 disclosed by  
20 JP 2001275347 published Oct. 5, 2001 and assigned to Toshiba Lighting & Technology Corporation. The reference numerals shown in the figure are those that appear in the abstract of this publication, and only the relevant components will now be described.

The power supply unit 10 includes a starting resistor 17 that feeds the output  
25 from a bridge rectifier 13 to a control circuit 16 on startup via a first transistor 18. A startup circuit feeds the output from the bridge rectifier 13 to the first transistor 18, thus maintaining the first transistor 18 conducting during starting and feeding power to the control circuit. A second transistor 21 is driven by a potential difference between the input and the output of a voltage regulator 22 and maintains  
30 constant voltage generated in a primary auxiliary winding 15b of an output



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transformer 15 after startup. The second transistor 21 feeds the resulting voltage to the control circuit, which is driven thereby, and inverts the first transistor from conduction to cutoff thereby effectively disconnecting the starting resistor 17.

Thus, the power supply unit saves electricity during standby by separating  
5 starting resistance after a startup (of a switching circuit), and driving the control circuit of a main switching element by only power generated in an output transformer.

It will be seen from Fig. 2 that an electrolytic capacitor 23 is connected across the input immediately after the bridge rectifier 13. The purpose of the  
10 electrolytic capacitor 23 is to store energy from the mains and serve as an auxiliary supply in the event of a momentary outage or fluctuations in the main voltage. In order to serve this function, the capacitor 23 must have a high capacitance and indeed this is the reason that an electrolytic capacitor is employed. However, the connection of a high capacitance at the input of the circuit militates against the  
15 power supply having near unity power factor. This may not matter too much when the power supply is to be used with computers and the like. However, there are many applications where near unity power factor is required and, in such cases, the circuit shown in JP 2001275347 is unsuitable.

In order to achieve near unity power factor, a high capacitance of the order  
20 of 200 nF is usually disposed near the output of the power supply. This increases the time that it takes for steady state to be reached and this in turn increases the time before the startup circuit must be disabled. In JP 2001275347 the time taken between the first switch 18 opening and the second switch 14 closing is too fast to allow complete charging of such capacitance. This also indicates that the circuit  
25 disclosed in JP 2001275347 is unsuited for use with power supplies having near unity power factor.

It would therefore be desirable to provide a startup circuit for a power supply, particularly a universal power supply having near unity power factor, wherein the starting resistor is disconnected after the power supply has reached  
30 steady state, thereby preventing energy loss and improving efficiency.

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## SUMMARY OF THE INVENTION

It is therefore an object of the invention to provide a startup circuit for a power supply having near unity power factor, having a starting resistor that is disconnected after the power supply has reached steady state, thereby preventing  
5 energy loss and improving efficiency.

To this end there is provided in accordance with the invention a startup circuit for a power supply, said startup circuit comprising:

- an input for connecting a source of high voltage thereto,
- an output rail for feeding rectified voltage to the power supply,
- 10 a first energy storage device coupled to the output rail for storing energy when voltage is first applied to the input,
- a second energy storage device coupled to an output of the power supply for storing energy when a voltage appearing at the output of the power supply reaches substantially steady state, and
- 15 a switching circuit coupled to the first energy storage device and to the second energy storage device and being responsive to the first energy storage device having sufficient energy for transferring said energy to the second energy storage device and disconnecting the first energy storage device from the output rail.

## 20 BRIEF DESCRIPTION OF THE DRAWINGS

In order to understand the invention and to see how it may be carried out in practice, a preferred embodiment will now be described, by way of non-limiting example only, with reference to the accompanying drawings, in which:

Fig. 1 is a partial circuit diagram showing schematically a conventional  
25 startup circuit in a typical low voltage power supply;

Fig. 2 is a partial circuit diagram showing schematically a prior art power supply;

Fig. 3 is a block diagram showing functionally an improved startup circuit according to the invention; and

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Fig. 4 is a partial circuit diagram showing schematically a practical embodiment of the startup circuit shown in Fig. 3.

#### DETAILED DESCRIPTION OF THE INVENTION

Fig. 3 is a block diagram showing functionally an improved startup circuit 30 according to the invention having an input 31 for connecting thereto a mains supply voltage (constituting a source of high voltage). Typically, such supply has a voltage of 110 VAC in the USA or 220 VAC in Europe. The input 31 is connected to a bridge rectifier 32 having an output 33 that feeds rectified voltage to a current source 34 that is coupled to one end of a capacitor 35 (constituting a first energy storage device) whose other end is connected to GND.

A normally open switching circuit 36 is coupled to the first capacitor and to a second capacitor 37 (constituting a second energy storage device) and is responsive to the output of a first comparator 38 having a first input 39 connected to the positive voltage terminal of the first capacitor 35 and having a second input 40 connected to a first reference voltage (VR1). The current source 34 is responsively coupled to the output of a second comparator 41 having a first input 42 connected to the positive voltage terminal of the second capacitor 37 and having a second input 43 connected to a second reference voltage (VR2). The rectified output 33 of the bridge rectifier 32 is fed to a power supply 44 that is designed to operate near unity power factor and has an output 45 that is fed to the cathode of a rectifier diode 46 whose anode is connected to the positive voltage terminal of the second capacitor 37.

Operation of the startup circuit 30 is as follows. Upon power-up, the constant source 34 feeds current into the first capacitor 35 and charges it to full charge. During this time, the rectifier output 33 feeds the power supply 44 and charges the output capacitor (not shown) therein which ensures that the power supply operates at or near unity power factor. The switch 36 is open, such that the first capacitor 35 is electrically isolated from the second capacitor 37. The power supply itself is not shown in Fig. 3, but once it is up and running it charges the

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second capacitor 37 via the rectifier diode 46. Thus when the circuit reaches steady state, the second capacitor 37 serves as a reservoir to the power supply in the event of momentary loss of supply voltage.

When the voltage across the first capacitor 35 exceeds the first reference  
5 voltage (VR1), the first comparator 38 produces a switching signal that causes the normally open switch 36 to close, thereby connecting the first capacitor 35 in parallel with the second capacitor 37 and transferring energy stored in first capacitor to the second capacitor. Likewise, when the voltage across the second  
10 capacitor 37 exceeds the second reference voltage (VR2), the second comparator 41 produces a switching signal that disconnects the current source 34, thereby preventing further charging of the first capacitor 35. The voltage thresholds VR1 and VR2 are chosen to be close to the voltages at full charge of the first and second capacitors, respectively. Thus, when the first capacitor 35 is substantially fully  
15 charged, the switch 36 closes and the stored energy in the first capacitor 35 is transferred to the second capacitor 37. This helps to boost the charge on the second capacitor 37, which reaches the voltage threshold VR2. When this occurs, the current source 34 is disconnected from the first capacitor 35, thus preventing it from becoming charged during steady state operation of the power supply and saving energy. As will be explained below with reference to Fig. 4 of the drawings,  
20 the current source 34 includes a resistor via which the first capacitor 35 is charged. So disabling the current source 34 prevents the flow of current through this resistor, which would otherwise be dissipated as ohmic losses.

Referring now to Fig. 4 there will be described a partial circuit diagram showing schematically an actual implementation of a startup circuit 40 operating as  
25 described above with reference to Fig. 3. Features that are common to both figures will be referenced by identical reference numerals. Thus, the input supply voltage 31 is fed to a bridge rectifier 32 whose positive output serves as an output rail 33 that is fed via a first voltage divider comprising resistors R1 and R2 connected in series to the collector of an NPN bipolar junction transistor Q1, whose emitter is  
30 connected to GND. A second voltage divider is formed by a resistor R3 connected

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at one end to the output rail 33 and connected in series at its other end to one end of a resistor R4 whose other end is connected to GND.

The emitter of a PNP bipolar junction transistor Q2 is connected to the output rail 33, its base is connected to the junction of the resistors R1 and R2, and its collector is connected via a resistor R5 to a first end of a first capacitor C1 whose second end is connected to GND and corresponds to the first capacitor 35 in Fig. 3. The junction of the resistors R3 and R4 is connected to the collector of an NPN bipolar junction transistor Q3, whose emitter is connected to GND. A resistor R6 is connected between the base and emitter of the transistor Q3 and its base is connected via a resistor R7 to the anode of a first zener diode D1 whose cathode is connected to a first end of a second capacitor C2 whose second end is connected to GND and corresponds to the second capacitor 37 in Fig. 3. The cathode of the first zener diode D1 is connected to the cathode of a rectifier diode D2, whose anode is connected to the positive supply rail of the power supply 44.

The first end of the second capacitor C2 is also connected to the collector of a PNP bipolar junction transistor Q4, whose emitter is connected to the first end of the first capacitor C1 and whose base is connected via a resistor R8 to the collector of an NPN bipolar junction transistor Q5. Between the base and emitter of the PNP bipolar junction transistor Q4 there is connected a resistor R9. The emitter of the transistor Q5 is connected to GND and its base is connected to the junction of a voltage divider comprising series connected resistors R10 and R11 connected between GND and the anode of a zener diode D3 whose cathode is connected to the first end of the first capacitor C1.

In an actual circuit reduced to practice the following circuit components were used, where significant:

Component	Value	Component	Value/Rating
R1	47K	C1	220 $\mu$
R2	100K	C2	22 $\mu$
R3	1.5M	D1	15V
R4	47K	D2	—

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Component	Value	Component	Value/Rating
R5	47K	D3	25V
R6	10K	Q1	FMMT458
R7	47K	Q2	FMMT558
R8	47K	Q3	PMBT222A
R9	10K	Q4	PMBT2907
R10	47K	Q5	BCV47

The startup circuit 40 is equivalent to the functional schematic shown in Fig. 3 and its operation is therefore identical. Thus, the PNP bipolar junction transistor Q2 in conjunction with the resistor R5 constitutes the current source 34 shown in Fig. 4. Resistors R1, R2, R3, R4 in combination with the transistor Q1 constitute a first switch 50 for controlling the current source 34. Resistors R10, R11 in combination with the zener diode D3 and the transistor Q5 constitute the first comparator 38, the breakdown voltage of the zener diode D3 establishing the first voltage threshold VR1. Likewise, resistors R6, R7 in combination with the zener diode D1 and the transistor Q3 constitute the second comparator 41, the breakdown voltage of the zener diode D1 establishing the first voltage threshold VR2. Resistors R8 and R9 in combination with the transistor Q4 constitute a second switch 36 corresponding to the switch 36 shown in Fig. 3 for coupling the first and second capacitors C1 and C2. The first switch 50 and the second switch 36 may be functionally considered as a switching circuit that is responsive to the first capacitor C1 having sufficient energy for transferring the energy to the second capacitor C2 and disconnecting the first capacitor C1.

On power-up, Q1 is cutoff and therefore the base potential of the transistor Q2 is substantially zero. Since Q2 is a PNP bipolar junction transistor it conducts current from the output rail 33 through the resistor R5, thereby charging the first capacitor C1. For so long as the voltage across the first capacitor C1 is less than the breakdown voltage of the zener diode D3, the base potential of the transistor Q5 is less than the  $V_{BE}$  breakdown voltage and Q5, being an NPN device, is therefore cutoff. Current flows from the current source 34 into the base of the transistor Q4.

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Since Q4 is a PNP device it is therefore cutoff and the first and second capacitors C1 and C2 are decoupled. When the voltage across the first capacitor C1 reaches the breakdown voltage of the zener diode D3, the base voltage of Q5 exceeds the  $V_{BE}$  breakdown voltage and transistor Q5 therefore conducts. This pulls the base voltage of the transistor Q4 down to GND, and Q4 being a PNP device also starts to conduct thereby coupling the first and second capacitors C1 and C2, whereby the stored energy in C1 flows into C2.

When the voltage across the second capacitor C2 reaches the breakdown voltage of the zener diode D1, the voltage across R6 exceeds the  $V_{BE}$  breakdown voltage of the transistor Q3 and Q5, being an NPN device, therefore conducts. This pulls the base voltage of the transistor Q1 down to GND, and Q1 being a NPN device cuts off. The voltage at the base of the transistor Q2 therefore goes high and Q2, being a PNP device, also cuts off thereby preventing the flow of current through the resistor R5, which would otherwise continue unnecessarily to waste energy.

The voltage across the second capacitor C2 is now maintained by the voltage output by the power supply 44 and the steady state operation of the power supply is therefore maintained without the continued operation of the startup circuit.

It will be appreciated that the functionality of the circuit shown in Fig. 3 can be realized using different circuit components than those shown in Fig. 4.

It will also be understood that the invention contemplates within its scope not only the startup circuit but also a power supply containing such a startup circuit, being either integral therewith or connected thereto externally. Such a power supply has been found to be particularly efficient for use in powering light emitting diodes (LEDs) and may be supplied as part of an LED lighting system. Moreover, such a power supply is amenable for connection across power supply sources of varying voltage, such as 85-277 VAC, and is equally efficient at all voltages in the range since the startup circuit is disconnected as soon as the power supply reaches steady state. Were this not the case, the voltage dropped across the resistor R5 would

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depend on the voltage on the output rail 33 and more energy would be wasted at higher supply line voltages. Thus, the drawback of variations in efficiency at different supply line voltages is avoided.

As has been noted, it is important that such power supplies have near unity  
5 power factor. To this end, a high capacitance at the input of the startup circuit as is used in JP 2001275347 must be avoided and power factor is reduced by means of a suitable power factor correction circuit in the power supply, or connected to an output thereof. Such power factor correction circuits are known *per se* and are not themselves a feature of the invention. However, the provision of power factor  
10 correction in power supplies intended for low power output, in the order of hundreds rather than thousands of watts, militates against the connection of high capacitance at the input of the startup circuit and the invention therefore embraces a power supply having power factor correction and the startup circuit as described.



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**CLAIMS:**

1. Startup circuit (30) for a power supply (44), said startup circuit comprising:  
an input (31) for connecting a source of high voltage thereto,  
an output rail (33) for feeding rectified voltage to the power supply,  
5 a first energy storage device (35) coupled to the output rail for storing energy when voltage is first applied to the input,  
a second energy storage device (37) coupled to an output of the power supply for storing energy when a voltage appearing at the output of the power supply reaches substantially steady state, and  
10 a switching circuit (36, 50) coupled to the first energy storage device and to the second energy storage device and being responsive to the first energy storage device having sufficient energy for transferring said energy to the second energy storage device and disconnecting the first energy storage device from the output rail.
- 15 2. The startup circuit according to Claim 1, wherein the first energy storage device is a first capacitor (35).
3. The startup circuit according to Claim 1 or 2, wherein the second energy storage device is a second capacitor (37).
4. The startup circuit according to Claim 2 or 3, including:  
20 a current source (34) connected to the input for charging the first capacitor, and  
a first comparator (38) having a first input (39) coupled to an output of the first capacitor (35) and having a second input (40) connected to a first reference voltage (VR1) for generating a first switching signal when the output of the first  
25 capacitor exceeds the first reference voltage;  
a second comparator (41) having a first input (42) coupled to an output of the second capacitor (37) and having a second input (43) connected to a second reference voltage (VR2) for generating a second switching signal when the output of the second capacitor exceeds the second reference voltage;

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said switching circuit (36, 50) being responsive to the first switching signal for changing from an initially open circuit wherein the first capacitor is isolated from the second capacitor to a closed circuit whereby the first capacitor is connected in parallel with the second capacitor; and being responsive to the second  
5 switching signal for disabling charge flow to the first capacitor.

5. The startup circuit according to Claim 4, wherein the switching circuit (36, 50) includes:

a first switch (50) coupled to the current source and having an initial state wherein the current source is coupled to the first capacitor and having a second  
10 state wherein the current source is decoupled from the first capacitor, and

a second normally open switch (36) coupled between respective outputs of the first and second capacitors.

6. The startup circuit according to Claim 5, wherein the first and second switches include semiconductor devices (Q1, Q4).

15 7. The startup circuit according to Claim 6, wherein the first and second switches are bipolar junction transistors (Q1, Q4).

8. The startup circuit according to any one of Claims 4 to 7, wherein the first comparator (38) includes a zener diode (D3).

9. The startup circuit according to any one of Claims 4 to 8, wherein the  
20 second comparator (41) includes a zener diode (D1).

10. The startup circuit according to any one of Claims 4 to 9, wherein the current source (34) includes a transistor (Q2) for feeding current through a resistor (R5).

11. The startup circuit according to any one of Claims 4 to 10, wherein the  
25 switching circuit (36) includes a first switch (50) comprising resistors (R1, R2, R3, R4) in combination with a transistor (Q1) for controlling the current source (34).

12. The startup circuit according to any one of Claims 4 to 11, wherein the switching circuit includes a second switch (36) comprising resistors (R8, R9) in combination with a transistor (Q4).

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13. A power supply including the startup circuit according to any one of Claims 1 to 12.
14. The power supply according to Claim 13, being an integral unit.
15. The power supply according to Claim 13 or 14, being part of an LED  
5 lighting system.
16. The power supply according to any one of Claims 13 to 15, including a power factor correction circuit.

## ABSTRACT OF THE DISCLOSURE

A startup circuit (30) for a power supply (44), has an input (31) for connecting to a source of high voltage thereo, and an output rail (33) for feeding rectified voltage to the power supply. A first energy storage device (35) is coupled to the output rail for storing energy when voltage is first applied to the input, and a second energy storage device (37) is coupled to an output of the power supply for storing energy when a voltage appearing at the output of the power supply reaches substantially steady state. A switching circuit (36, 50) is coupled to the first energy storage device and the second energy storage device and is responsive to the first energy storage device having sufficient energy for transferring the energy to the second energy storage device and disconnecting the first energy storage device from the output rail.

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